[19] Patent Office of the People's Republic of China [11] Publication no.: CN 2082755U (68)

3

[12] Published Specification of Utility Model Patent Application

[21] Appl. no. 91214135.2

[51] Int. Cl[3]
E21B 10/50

[43] Publication date: August 14, 1991

[22] Filing date: 2/2/91

[71] Applicant:
Southwest Petroleum Institute
Address:
No. 6 Petroleum E. Rd., Nanchong City,
Sichuan Province, 637001

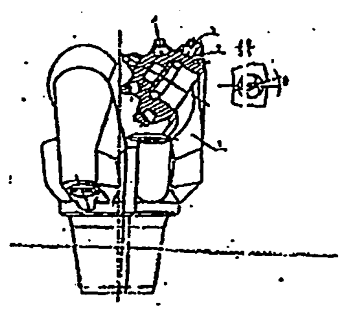
[72] Designers:
Ma Dekun, Hou Jikang, Lin Yuhua, Lee Shusheng , YangYinxing

Description 2 pages, Drawings 1 page

[54] Title of invention: Twisted-Tooth Tri-Roller Cone Bit

[57] Abstract

The present utility model is a type of insert tri-roller cone bit for petroleum and natural gas boreholes. It structurally differs from existing insert tri-roller cone bits in that the centerlines of the tips of the teeth inserted in the bit are not parallel to the centerline of the cone. Rather, when the bit is in an inverted position, the centerlines of the tips of the insert teeth are twisted counterclockwise at a certain angle relative to the cone centerline. Rock-breaking efficiency can be greatly increased, and well-drilling costs reduced, by using different twist angles for different tooth rows on each roller cone, depending on the conditions of different strata. It is not necessary to change other structural parameters.



(BJ)第1452号

CLAIMS

1. A type of insert tri-roller cone bit for petroleum and natural gas boreholes, primarily composed of a bit body, roller cones, and teeth, and characterized by the fact that the centerlines of the tips of said teeth are twisted at a certain angle relative to the centerline of the cone.

2. The insert tri-roller cone bit as described in claim 1, characterized by the fact that, when the bit is in an inverted position, the centerlines of the cutting insert tips are twisted counterclockwise 0° to 40° relative to the centerline of the cone.

DESCRIPTION

Twisted-Tooth Tri-Roller Cone Bit

The present utility model relates to a type of insert tri-roller cone bit which is especially suited to moderately soft to moderately hard strata in petroleum and natural gas well-drilling and is used to raise the rock-breaking efficiency of the bit.

At present, the insert tri-roller cone bits in use in China and abroad are primarily composed of a bit body, roller cones, and teeth. In those in which wedge-shaped teeth or spoon-shaped teeth are inserted, the tooth tip centerlines are parallel to the centerlines of the cones. When bits have this type of structure, rock-breaking efficiency at the borehole bottom is to some degree diminished, and mechanical drill speed is lower during penetration. The reason for this is that, during penetration, the teeth tend to slide radially and tangentially at the borehole bottom. The tangential sliding speed is the sliding speed tangential to the tooth track. Radial sliding speed means the sliding speed of the teeth along the roller cone axis in the borehole bottom projection direction. The tooth sliding speed at the borehole bottom is a combination of its tangential sliding speed and its radial sliding speed. In all existing models of drill bits, the teeth are inserted so that the centerlines of tooth tips are parallel to the centerlines of the cones. In tri-roller cone bits having this type of structure, the tooth tip centerlines are not perpendicular to the sliding speed direction of the teeth at the borehole bottom. Therefore, the scraping area of the teeth at the borehole bottom is smaller, and its rock-breaking efficiency is lower. The object of the present utility model is to provide a high-efficiency twisted-tooth tri-roller cone bit that increases the scraping area of the teeth and thereby increases rock-breaking efficiency.

The present utility model has the same main components as other existing bits. All are primarily composed of a bit body, roller cones, and teeth. The difference is that in the present utility model, the centerlines of the tips of the teeth inserted in each row on the insert tri-roller cone bit are twisted from the centerline of the cone by a certain angle θ. The twist angles of the teeth on different rows of each roller cone are basically different. The twist orientation should ensure that, when the bit is in the inverted position, looking at the roller cones, the tooth tip centerlines are twisted counterclockwise relative to the cone centerline. The twist angles should be selected so as to ensure that the centerlines of the tips of the teeth on each row are perpendicular to the sliding speed direction of the teeth at the borehole bottom.

The size of twist angle θ can be determined through the following algebraic formula:

$$\theta = \frac{1}{n}\sum_{i=1}^{n} arctg\left(\frac{\lambda_r r\omega_i}{\rho\omega_0 - \lambda_t r\,\omega_i}\right)$$

where

$$\lambda_r = \frac{0.5r\cos\beta^2\sin 2\alpha - C\sin\beta\sin\alpha - S\cos\alpha}{\rho}$$

$$\lambda_t = \frac{C\cos\alpha - S\sin\beta\sin\alpha + r\sin\beta}{\rho}$$

$$\rho = \sqrt{(C + r\sin\beta\cos\alpha)^2 + (r\sin\alpha - S)^2}$$

r is the tooth row radius, ω_0 is the angular speed of the drill bit, ω_i is the angular speed of the roller cone, β is the complement angle to the angle defined by the bit axis and the roller cone axis, S is the roller cone offset axis distance, C is the distance between the center of the tooth row and the projection of the bit axis onto the surface of the roller cone; α is the rotation angle around the roller cone axis for a point on the tooth tip centerline. All these parameters can be theoretically and experimentally determined. The present utility model takes advantage of the twisting of the teeth to cause the tooth tip centerlines on each row of teeth of the three roller cones to be perpendicular to the sliding speed direction of the teeth at the borehole bottom. Thus, it effectively increases the scraping areas of the teeth and raises the mechanical drilling speed. Once the improvement is made to the original insert tri-roller cone bit, the assembly cost of the present utility model basically remains unchanged.

Further explanation of the present utility model is provided below in light of the attached drawing:

The attached drawing is a general assembly drawing of an inset tri-roller cone bit in accordance with the present utility model.

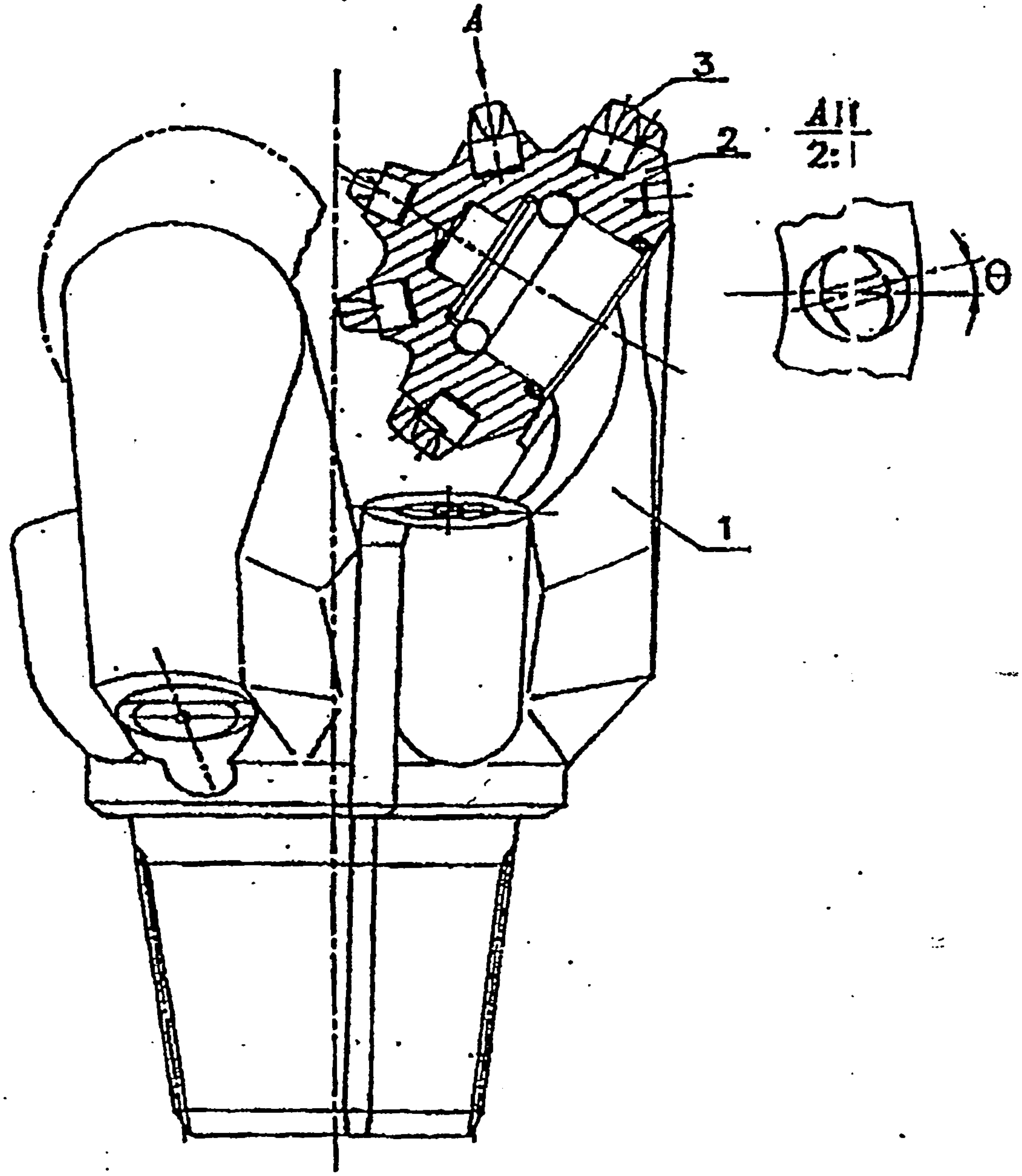
1 is a bit body; 2 is a roller cone; 3 is a tooth. The A view shows the twisting direction of the twist angle θ. The best twist angles θ for said tooth tip centerlines according to the present utility model are between 0° and 40°.

Site test results show that use of the present utility model results in a significantly higher rock-breaking efficiency of the insert tri-roller cone bit. The mechanical drill rate can increase by 18.9% to 80%, greatly lowering well-drilling costs and raising economic efficiency.

ABSTRACT

The present utility model is a type of insert tri-roller cone bit for petroleum and natural gas boreholes. It structurally differs from existing insert tri-roller cone bits in that the centerlines of the tips of the teeth inserted in the bit are not parallel to the centerline of the cone. Rather, when the bit is in an inverted position, the centerlines of the tips of the insert teeth are twisted counterclockwise at a certain angle relative to the cone centerline. Rock-breaking efficiency can be greatly increased, and well-drilling costs reduced, by using different twist angles for different tooth rows on each roller cone, depending on the conditions of different strata. It is not necessary to change other structural parameters.

DRAWING



EPO - DG 1

02 09. 2004

(68)

(19) 中华人民共和国专利局

(11)公告号 CN 2082755U

(12)实用新型专利申请说明书

[21] 申请号 91214135.2

[51] Int.Cl⁵
B21B 10/50

(43) 公告日 1991年8月14日

[22]申请日 91.2.2

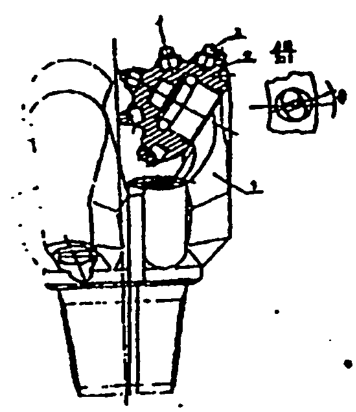
[71]申请人 西南石油学院
地址 637001 四川省南充市石油大路8号
[72]设计人 马德坤 侯季康 林天龙
李树盛 杨迎新

说明书页数: 2 附图页数: 1

[54]实用新型名称 偏转镶齿三牙轮钻头

[57]摘要

本实用新型是一种用于石油与天然气钻井的镶齿三牙轮钻头，与现有的镶齿三牙轮钻头结构不同，其特点在于这种钻头所镶牙齿的齿顶中心线不与牙轮锥体母线平行，而是在钻头处于侧置位置时所镶牙齿的齿顶中心线相对于牙轮锥体母线方向反时针偏转了一定角度。根据不同地层条件，只要各牙轮不同齿圈采用不同的偏转角，而不改变其它结构参数，即可大大提高破岩效率，降低钻井成本。



<27>

权 利 要 求 书

1、一种用于石油与天然气钻井的镶齿三牙轮钻头，主要由牙爪，牙轮和牙齿组成，其特征在于所说的牙齿齿顶中心线相对于牙轮锥体母线方向偏转一定角度。

2、按权利要求1所述的镶齿三牙轮钻头，其特征在于钻头处于倒置位置时牙齿齿顶中心线应相对牙轮锥体母线方向反时针偏转0°～40°角。

偏转镶齿三牙轮钻头

本实用新型涉及一种镶齿三牙轮钻头，特别适用于石油与天然气钻井中极软至中硬地层，用以提高钻头破岩效率。

目前国内外所使用的镶齿三牙轮钻头主要都是由牙爪、牙轮及镶嵌的牙齿所组成，其中楔形齿和勺形齿的镶装方式都是使牙齿齿顶中心线与牙轮锥体母线平行，这种结构的钻头在一定程度上影响了牙齿在井底的破岩效率，钻进时的机械钻速较低。这是由于当三牙轮钻头钻进时，牙齿在井底会产生径向滑动和切向滑动。切向滑动速度是与牙齿的轨迹圆相切的滑动速度，径向滑动速度是指牙齿沿牙轮轴线在井底投影方向上的滑动速度。切向滑动速度与径向滑动速度的合速度就是牙齿在井底的滑动速度。现有的各型钻头的牙齿都是按牙齿齿顶中心线与牙轮锥体母线平行的结构镶装而成的。这种结构的三牙轮钻头因牙齿齿顶中心线不与牙齿在井底的滑动速度方向垂直，故牙齿在井底的刮切面积较小，破岩效率较低。本实用新型的目的在于提供一种可高效破岩的偏转镶齿三牙轮钻头，可相应增大牙齿刮切面积，提高破岩效率。

本实用新型与现有各型钻头相比，组成的部件相同，主要都是由牙爪、牙轮和牙齿组成，不同之处在于本实用新型镶齿三牙轮钻头上内部各齿圈所镶牙齿齿顶中心线相对于牙轮锥体母线偏转了一定角度0，各牙轮不同齿圈上的牙齿偏转角基本不同，偏转方向应保证当钻头在倒置位置时，面对牙轮，牙齿齿顶中心线相对于牙轮锥体母线方向反时针偏转，偏转角的选择应保证各排齿圈上的牙齿齿顶中心线与牙齿在井底滑动速度方向相垂直。

偏转角0的大小可由下列代数式确定：

$$0=\frac{1}{n}\sum_{i=1}^{n}\operatorname{arctg}\left(\frac{\lambda_i r\omega_i}{p\omega_0-\lambda_i r\omega_i}\right)$$

其中 $\lambda_r = \dfrac{0.5r\cos\beta^2\sin2\alpha - C\sin\beta\sin\alpha - S\cos\alpha}{\rho}$

$$\lambda_t = \frac{C\cos\alpha - S\sin\beta\sin\alpha + r\sin\beta}{\rho}$$

$$\rho = \sqrt{(C + r\sin\beta\cos\alpha)^2 + (r\sin\alpha - S)^2}$$

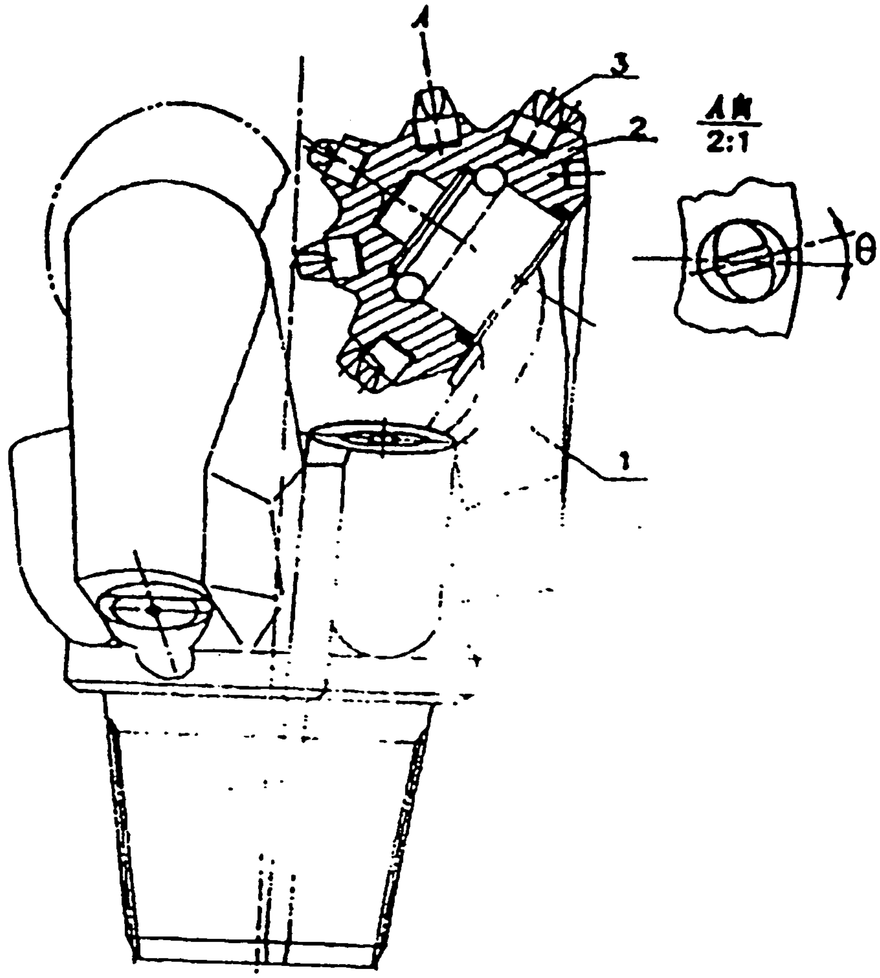
r 为齿圈半径，ω_0 为钻头转动角速度，ω_1 为牙轮转动角速度，β 为钻头轴线与牙轮轴线夹角的余角，S 为牙轮移轴距，C 为齿圈中心到钻头轴线在牙轮轴面上投影的距离，α 为牙齿齿顶中心线上一点绕牙轮轴线转动的角度。这些参数都可由理论和实验确定。本实用新型利用了牙齿的偏转，使三个牙轮各排齿圈上的牙齿齿顶中心线与牙齿在井底滑动速度方向相垂直，有效地增大了牙齿刮削面积，提高了钻井的机械钻速。本实用新型在原有镶齿三牙轮钻头基础上改进后，钻头加工成本基本不变。

以下结合附图对本实用新型作进一步说明：

附图为本实用新型所描述镶齿三牙轮钻头的总装图；

1 为牙爪；2 为牙轮；3 为牙齿，A 向视图表征偏转角 θ 的偏转方向，本实用新型所描述的牙齿齿顶中心线最佳偏转角 θ 在 0°～40°范围内。

使用本实用新型进行的现场试验结果表明，采用本实用新型后，显著地提高了镶齿三牙轮钻头的破岩效率，机械钻速可提高 18.9%～80%，大大地降低了钻井成本，提高了经济效益。


A
3
2
A向
2:1
θ
1